CubeSatCam

Cal Poly Workshop

April 2010

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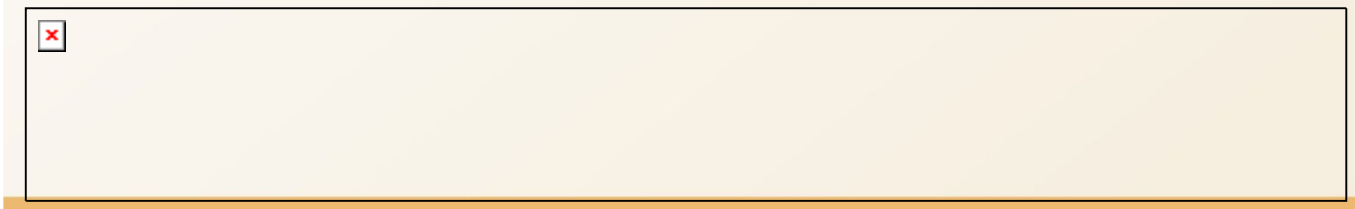
New Mexico Space Grant

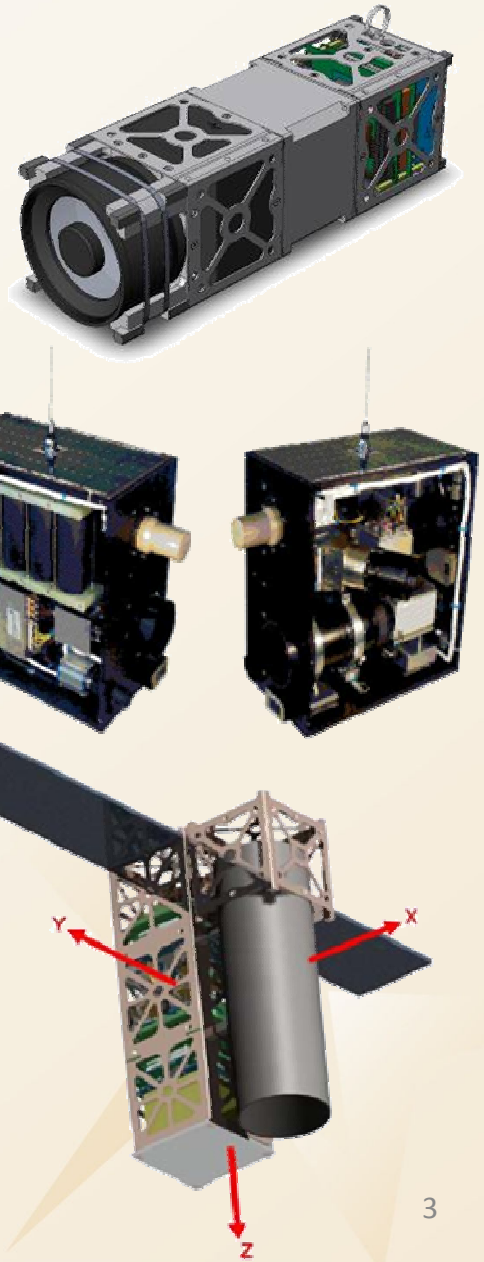


Introduction

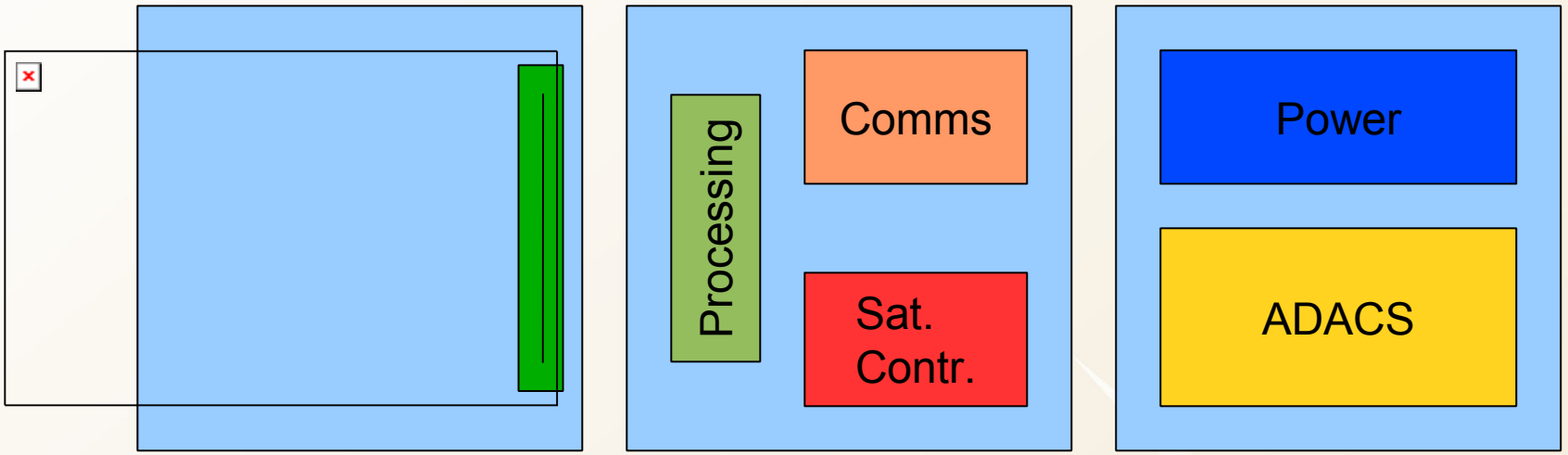
- Common theme among CubeSat projects:
  - Sacrifice quality for reduced size, weight and cost
  - Components interact to improve overall function
- Nano-satellites could provide surveillance
  - High-quality, diffraction-limited optics
- Reduction of moving parts
  - Re-orient satellite for different tasks

Background

- CubeSat Cam (SAU, Columbia)
  - 752x480, 60 fps
- Pumpkin MISC Satellite
- LAPAN-TubSat
- NPS TinyScope



Design Overview



Unit 1
- Schmidt-Cassegrain
- CMOS Imager

Unit 2
- Image processing
- Communications
- Satellite Control

Unit 3
- ADACS
- Batteries

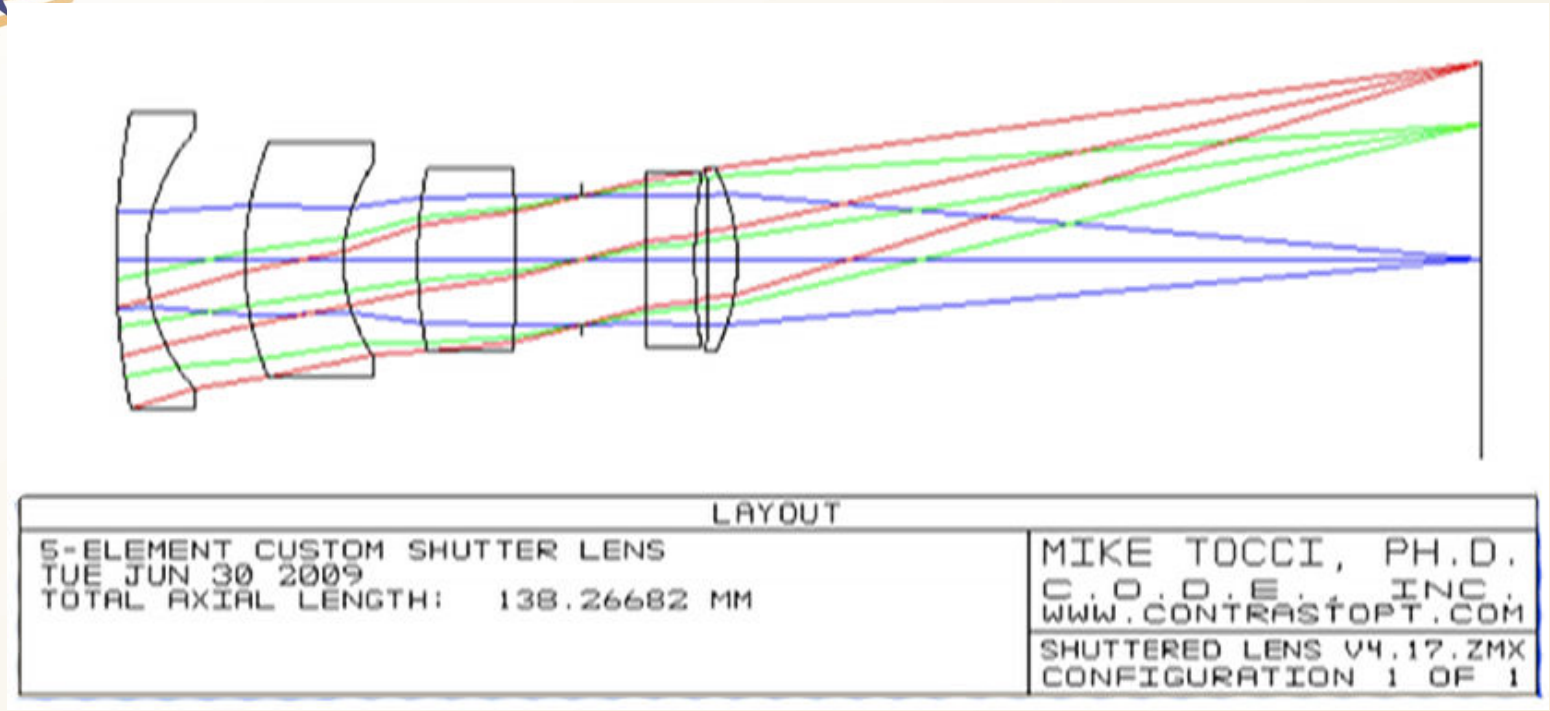
Schmidt-Cassegrain

- Glass elements are heavy
  - Light-weight mirrors
  - Can approach diffraction limit (for a cost)
    $\Theta=1.22\lambda/d$, d=9cm, λ=100nm
- Simple two-element design
  - Could be deployable
  - Save almost a whole U of volume
  - Complicates the design considerably

Flutter Shutter

- Work at UMIACS has proven feasibility of removing motion blur using
  - Coded exposure, Deconvolution
  - Guess or optimize for blur width in pixels
- Could mitigate CubeSat photography
  - ADACS can estimate motion blur conditions
  - Appropriate shutter waveform can be generated
  - Image can be de-blurred online or on the ground

Optics Proof of Concept



- Uniblitz shutter VS14S 2 T 1 -105
- Sony Alpha A900 camera sensor

Airborne Demo Ready

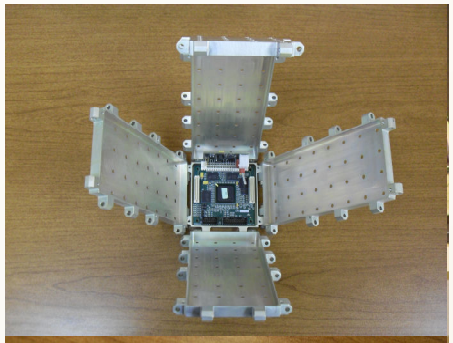
CMOS Imager

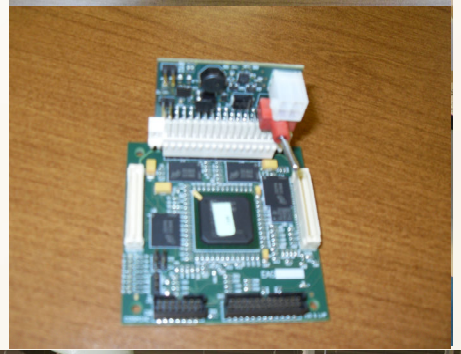
- Much lower power than CCD architecture
- Acquired Dalsa sensor
  - 12 megapixels
  - 10 fps
  - Global electronic shutter
    - Facilitate coded exposure (later)

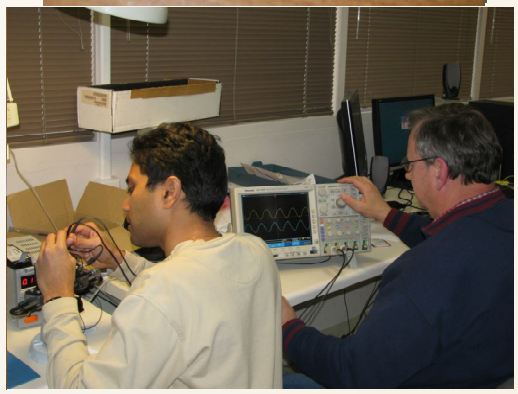
Image Processing

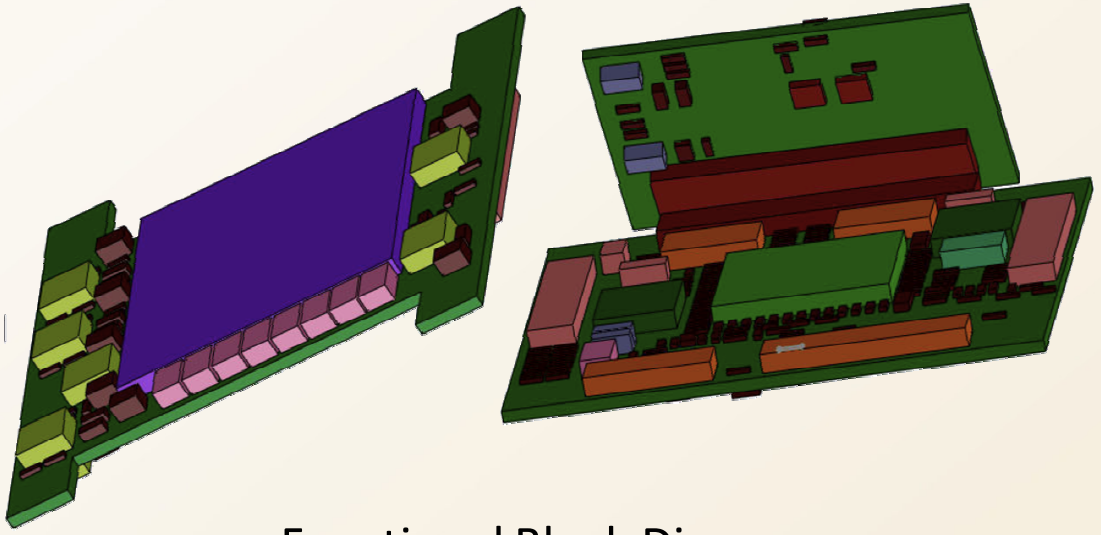
- High-performance FPGA with Microprocessor
  - HW/SW Codesign Solutions
- Assessment of image quality
  - Exposure
  - Blur metrics
  - Good/bad decision
- Compression/Geo-registration

Modular Processing Boards

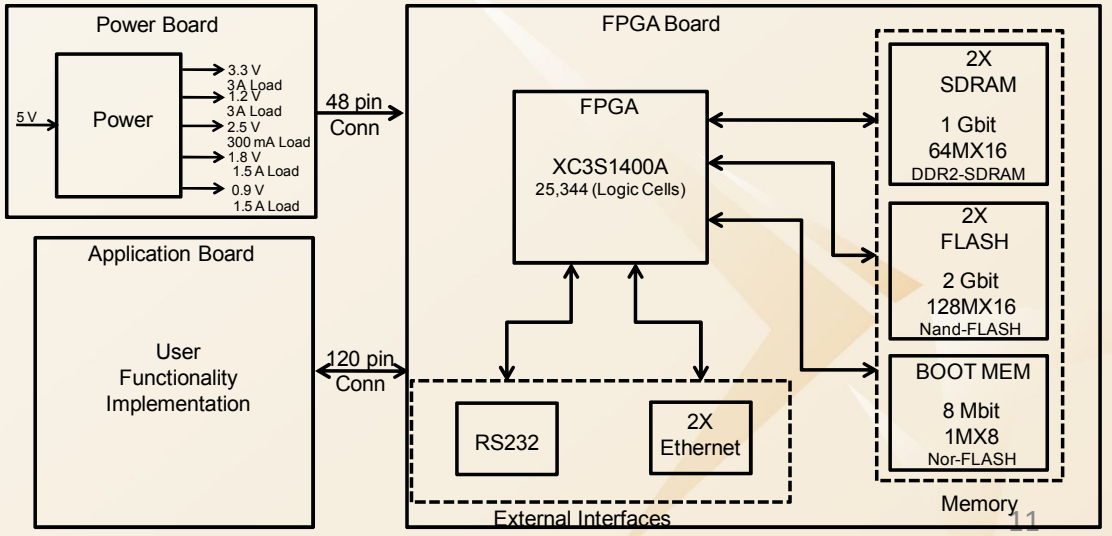








Functional Block Diagram



Satellite Control

- Low-speed, high-reliability system
- Monitor and command all other systems
  - Reset unresponsive components
  - Enter low-power modes
- Includes a low-speed communication channel
  - Status: position, heading, attitude
  - Command/control: Acquire target, transmit image

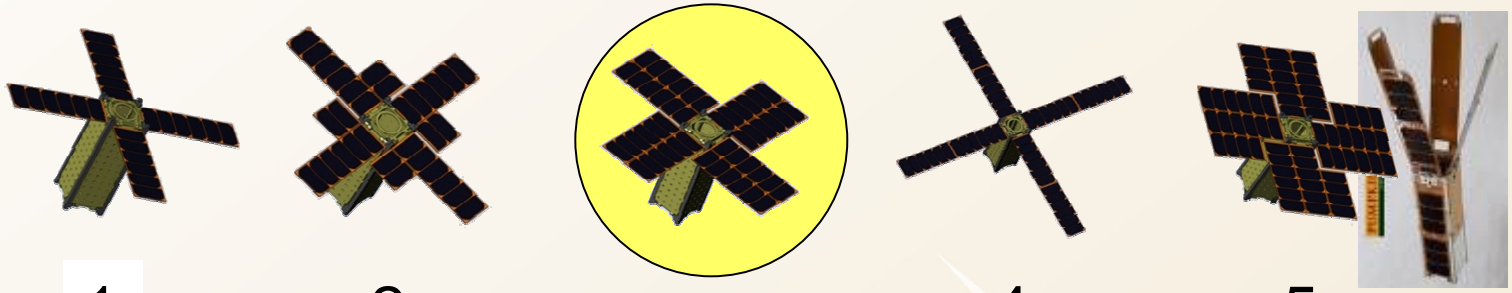
ADACS

- Attitude Determination
  - GPS
  - MEMS accelerometers
  - Magnetometer
- Attitude Control
  - Reaction wheels
  - Electomagnets

Power Generation

COSMIAC www.cosmiac.org

Potential Deployable Solar Panel Configurations



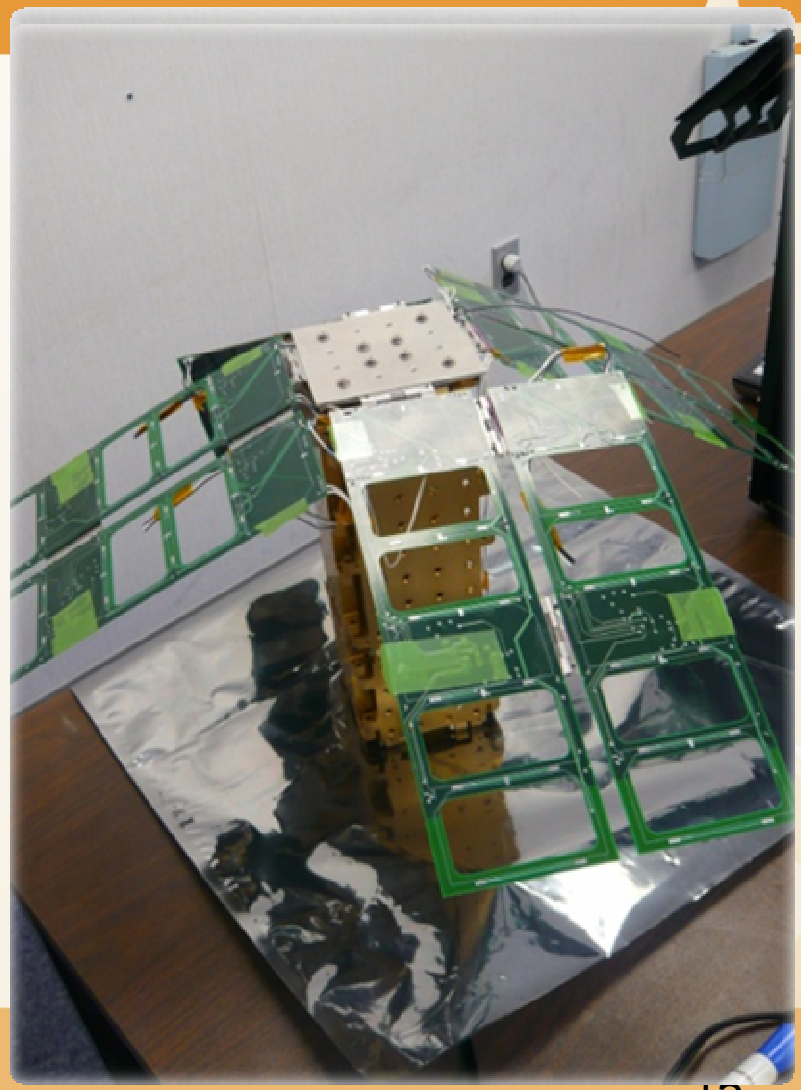
1 2 3 4 5 6

Configuration	1	2	3	4	5	6
Number of cells	**24**	**32**	**48**	**48**	**64**	**72**
Approx mass w/hinges (g)	**99.6**	**148.3**	**222.4**	**222.4**	**296.5**	**100**
Approx Max power gen. *(W)	**28.0**	**37.3**	**55.9**	**55.9**	**74.5**	**18.8**
Orbit average power (W)**	**11.8**	**15.7**	**23.5**	**23.5**	**31.4**	**8.2**

* Using 29.9% efficiency solar cells

** Based on 80% energy conversion efficiency

Solar Panel Deployment



Conclusion

- Evaluated Optical Design
- Proof of Concept of Coded Exposure
- Modular Processing Board Design
- Deployable Solar Panels and Power Mgt.
- Come see us at the COSMIAC booth